# The 1997 GRAPWG Report Lessons Learned?

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# What Was Known and Unknown in the Mid-1990's

**Resources**

Compton Observatory – AGN, pulsars, solar flares, GRBs, diffuse continuum, diffuse 511 keV, diffuse Al-26, unidentified sources

X-rays – ROSAT, ASCA, RXTE (1995 launch)

TeV – handful of sources

**Limitations**

Unknown GRB distances (BeppoSAX breakthrough was in 1997)

No Swift, Chandra, or XMM X-ray telescopes

No multi-messenger facilities

No high-resolution gamma-ray line instruments in orbit (INTEGRAL was being built)

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Lesson: new discoveries can change priorities. FIGSAG should be open to this possibility.

# The GRAPWG Process

**The 16 members of the Gamma Ray Astronomy Program Working Group met several times. Much of the discussion focused on science, with emphasis on questions that future gamma-ray missions had some chance of answering.**

*KEY QUESTIONS IN HARD X-RAY AND GAMMA RAY ASTRONOMY*

- *What is the origin and nature of gamma ray bursts?*
- *What are the physical conditions and processes near accreting black holes and neutron stars?*
- *How does matter behave in extreme conditions like those in neutron stars, supernova explosions and active galactic nuclei?*
- *How do astrophysical accretion processes work and what are their instabilities, periodicities and modes?*
- *What is the nature of the jets emanating from galactic black holes and AGN and how are the particles accelerated?*
- *What is the origin of the diffuse gamma ray background?*
- *What is the nature of the unidentified high energy gamma-ray sources?*
- *Where are the sites of nucleosynthesis?*
- *How do supernovae work? What are the progenitors and explosion mechanisms? What has been the rate in the last several hundred years?*
- *What and where are the sites of cosmic ray acceleration?*

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Lesson: FIGSAG needs a similar list of questions based on current knowledge.

# The GRAPWG Recommendations/Outcomes

| **Intermediate Missions ($75K - $300K)** | **Outcome** |
|---|---|
| HIGHEST PRIORITY - A next-generation 10 Mev to I00 GeV gamma-ray mission | Fermi (2008) |
| A focusing hard X-ray telescope | NuSTAR (2012) - SMEX |
| A next-generation nuclear line and MeV continuum mission (follow-on to INTEGRAL) | COSI (2027) - SMEX |
| **SMEX and MIDEX Missions** | |
| A gamma-ray burst localization mission | HETE-2 (2000), Swift (2004) |
| A hard X-ray all-sky survey and monitor mission | MAXI (2009) |
| **Other Recommendations** | |
| Maintain ongoing missions, especially CGRO and RXTE | CGRO ended in 2000; RXTE in 2012 |
| Support INTEGRAL, technology, balloon program, data analysis, theory, and TeV telescopes | Mixture. Not all of these have been supported at a high level. |

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Lesson: Constraining the cost for even the highest-priority mission is important. Only one of these recommendations achieved Intermediate (now called Probe)-class funding.

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Lesson: Having ONE recommendation listed as highest priority is valuable.

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Lesson: Unless a special case like the GRB distance discovery is made, the time scale for a new mission is ~10 years or more.

# Additional Notes

Technical feasibility to achieve major improvements in performance can make recommendations stronger.  The use of silicon strips as a tracker was an enabling technology for Fermi Large Area Telescope. Multilayer mirrors had reached a high level of maturity, making NuSTAR a realistic mission.

The 1997 GRAPWG report helped focus NASA's attention on gamma-ray astrophysics.  It was fairly successful in seeing its recommendations reach fruition.  I certainly hope the report from this group will be equally or more successful.